

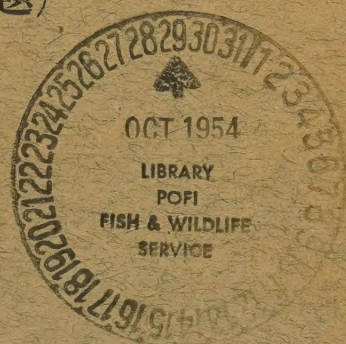
東 北 大 学

浅虫臨海實驗所報告

(海洋生物時報 改題)

第七卷 第一号

昭和二十九年三月



THE
BULLETIN
OF
THE MARINE BIOLOGICAL STATION
OF ASAMUSHI
TÔHOKU UNIVERSITY

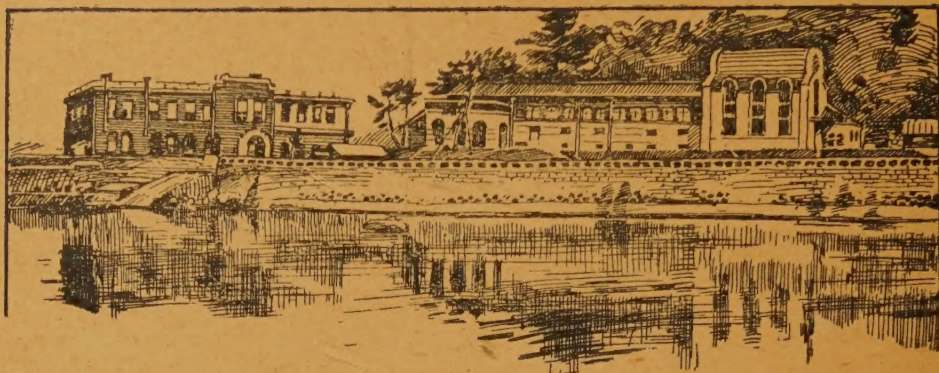
Vol. VII, No. 1

(March, 1954)

Asamushi, Aomori Prefecture
JAPAN

東北大學附屬臨海實驗所

青森縣浅虫



ANNOUNCEMENT

The Change of the Japanese Title of the Journal

This journal has been published under the Japanese title "Kaiyô Seibutsu Jihô" ("The Journal of Marine Biology"). This title, however, expresses nothing proper to the Tôhoku University, to which the Station belongs, or to Asamushi where the Station is situated, while the English title "The Bulletin of the Marine Biological Station of Asamushi" seems more appropriate. The Japanese title has, therefore, been changed "Asamushi Rinkai Jikkenjo Hôkoku" in accordance with the English title. The latter will remain unchanged. The series of the new title will succeed the number of the volume of the previous series.

It may also be announced, by the way, that contributions from the Marine Biological Station have been numbered only when published in the Science Reports of the Tôhoku University (Biology), but those which will be published in this journal will also be numbered hereafter.

本紙改題に就いて

本誌は従来 (海洋生物時報) なる誌名を以て刊行されて来たが、此の名称は本実験所の所属する東北大学或は所在地浅虫の何れを示す文字をも含まず従つてその個性を端的に表はさない恨があつた。且つ英文名ともその意義の一致を欠いていた。依つて此度英文名とも一致する表記の題名 [浅虫臨海実験所報告] と変更した次第である。巻号数は従来 (海洋生物時報) の巻号数を継承することにした。

因に本実験所業績の番号は 従来東北大学理科報告 (生物学) に発表の論文にのみ附してあつたが、今後は本誌に発表の論文にも番号を附することにした。

ON THE ROWS OF STIGMATA OF THE ASCIDIAN,
PEROPHORA ORIENTALIS ÄRNBÄCK*

By

ETURO HIRAI

平井越郎

*Marine Biological Station of Asamushi,
Aomori Prefecture, Japan*

(With 5 Figures)

Two species of genus *Perophora* can be collected in the sea near the Misaki Marine Biological Station, Kanagawa Prefecture (Yatsu, 1941). One of them is *P. japonica* Oka which has a Japanese species name Mameboya, and the other is *P. orientalis* Ärnback. The writer wishes to propose a Japanese species name Tsuyuboya for *P. orientlis* in this paper.

On the rows of stigmata of *P. orientalis*, Ärnback (1935) maintained five rows, and Yatsu (1941) also described that this species has five rows of stigmata. The present writer observed the formation of the rows of stigmata of the blastozooids, and he suggests in this paper that the presence of four rows of stigmata would be an important character of this species, in addition to the form of five rows.

Before going further the writer thanks to Prof. Motomura and Prof. H. Oka for their kind suggestions and to the late Dr. K. Kikuchi and Dr. T. Iida for their kind aids given to the writer in collection.

Material and Method

In August of 1943 and 1947, the materials were collected on a narrow and plane rock in the sea shore near the Misaki Marine Biological Station, and were preserved in 10 % formalin and Bouin's solution. The observation was carried out with the whole preparations of materials which were stained by Borax-carmin and mounted in glycerin and balsam.

Observation

The formation of the rows of stigmata was investigated with the developing

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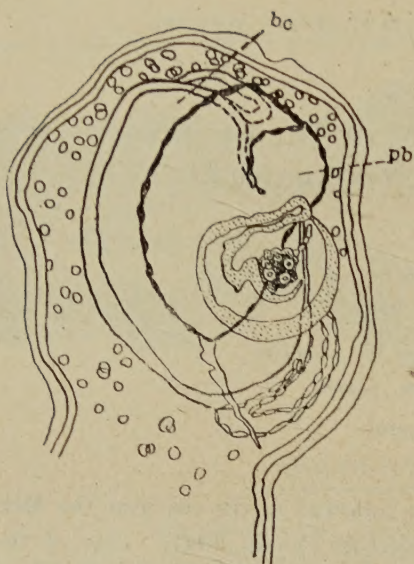


Fig. 1.

Left side view of a young bud of *ca.* 0.3 mm, showing the rudiments of branchial and peribranchial chambers. $\times 160$. *bc* rudiment of branchial chamber, *pb* peribranchial chamber.

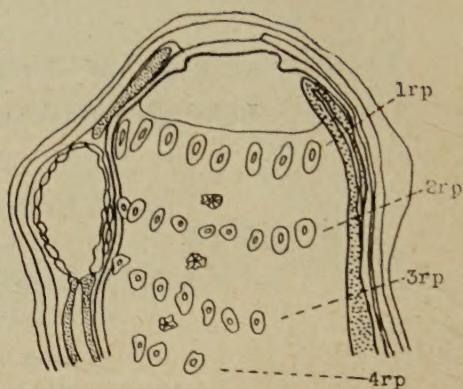


Fig. 2.

Right side view of a young bud, *ca.* 0.4 mm in length and *ca.* 0.3 mm in width, showing the formation of the primary four rows of stigmata. $\times 160$. 1-4rp first, second, third and fourth rows of the primary stigmata.

young blastozooids. In the young spherical buds, *ca.* 0.3 mm in diameter, the rudiments of the branchial and peribranchial chambers were observed, but the rudiments of the stigmata were not yet formed (Fig. 1). In the young buds, *ca.* 0.4 mm in length and *ca.* 0.3 mm in width, four rows of stigmata were observed. The stigmata of the first row were longer than those of other rows. The stigmata of the first row are seven to eight, and those of the second row are nine in numbers (Fig. 2, 1-4rp). In the young buds, *ca.* 0.6 mm in length and 0.5 mm in width, eight long stigmata of the first row, about 13 stigmata of the second row, about 13 stigmata of the third row, and about 10 stigmata of the fourth row were observed. In this stage, the rudiments of the secondary new stigmata were observed on the same line of the first row. These new stigmata consists of pairs, made of upper and lower ones, and they were formed between the stigmata of the first row and on both sides of this row. According to the formation of the secondary stigmata, a new form of five rows was formed added to the primary form of four rows in this stage (Fig. 3, *us* and *ls*). In the young buds, *ca.* 0.9 mm in length and *ca.* 0.7 mm in width, the secondary stigmata developed longer and were 13 in number, and the primary stigmata were eight in this stage (Fig. 4, *us*

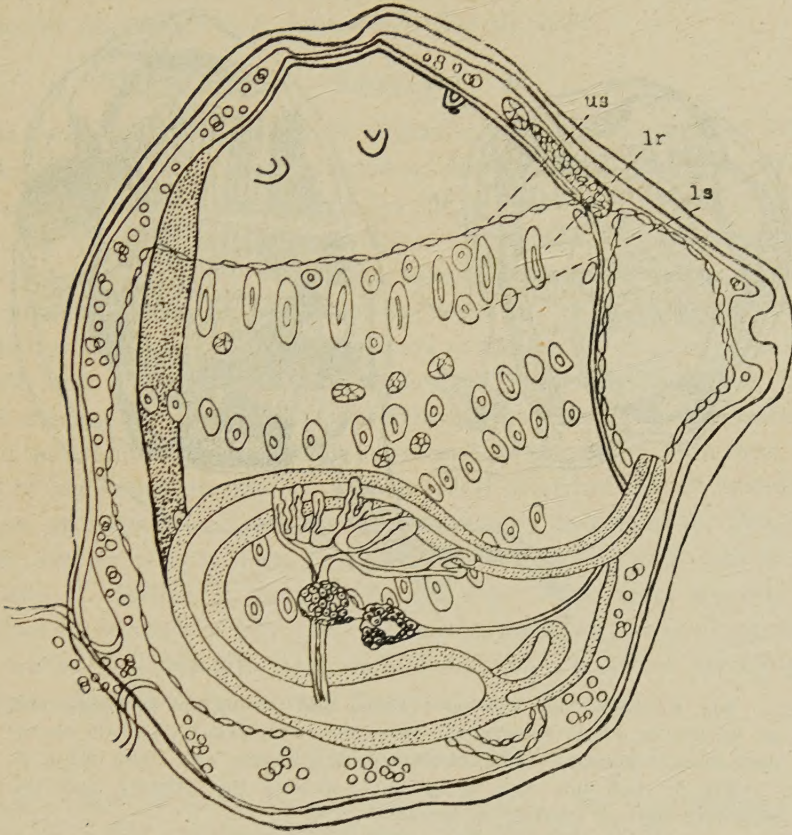


Fig 3 Left side view of a young bud, *ca.* 0.6 mm in length and *ca.* 0.5 mm in width, showing the formation of the secondary rows of stigmata on the first row. $\times 160$. *lrp* first row of the primary stigmata, *us*, *ls* upper and lower stigmata of the secondary stigmata respectively.

and *lrp*). In the adult, the primary and fundamental eight stigmata of the first row were observed as in the young buds, and *ca.* 23 of the total stigmata of the first row were observed with the pairs of the upper and the lower of the secondary stigmata. The length of the primary stigma is double the length of a secondary pair. The length of the stigmata of the other rows is nearly same as the secondary stigmata (Fig. 5). According to this investigation, the writer observed that this species has tow forms of rows of stigmata, the primary form of four rows and the secondary form of five rows. The writer also observed the primary four rows of stigmata in the tadpole larva of this species.

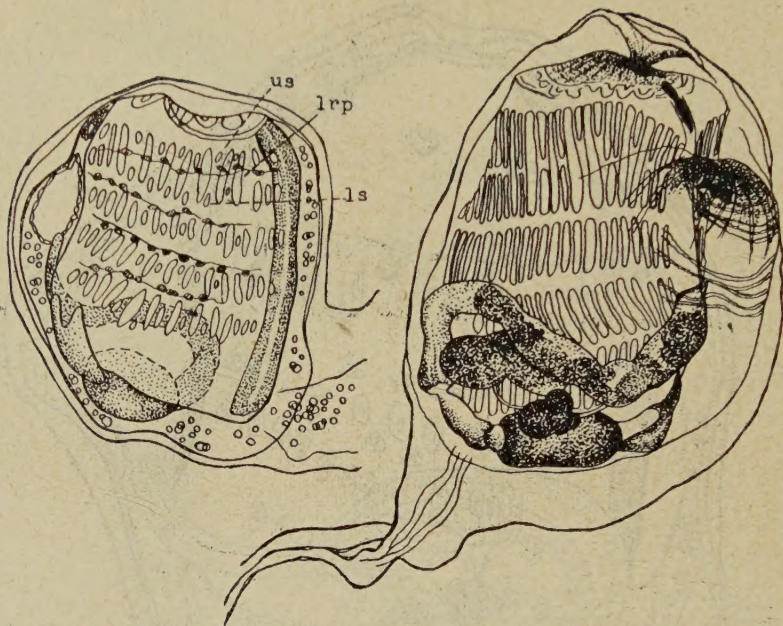


Fig. 4.

Fig. 5.

Fig. 4 Right side view of a young bud, *ca.* 0.9 mm in length and *ca.* 0.7 mm in width, showing the formation of the primary and the secondary rows of stigmata. $\times 50$. Abbreviations are same with those of Fig. 3.

Fig. 5. Left side view of an adult, showing the primary and the secondary rows of stigmata in the adult. $\times 30$.

Consideration

On the rows of stigmata of *Perophora orientalis*, Ärnback (1935) described "It has 5 rows of stigmata, even in the small individuals, and up to c. 24 long, narrow stigmata in each row. A few stigmata in the 1st and the 2nd rows are of double length and common to both rows, though crossed by the transvers vessels", and he took note the character of five rows of stigmata. Yatsu (1941) described that *P. japonica* has four rows and *P. orientalis* has five rows of stigmata. According to the writer's investigation, in the young buds, *ca.* 0.4 mm in length and *ca.* 0.3 mm in width, the rows of stigmata are four in number. And the secondary upper and lower two rows are added on the line of the primary first row at the stage of the buds of *ca.* 0.6 mm in length and *ca.* 0.5 mm in width. And the primary form is visible even in the adult. The present writer counted four long stigmata of the first row in the figure of Ärnback. According to the writer's observation they were eight in number fundamentally. The present writer considers that the rows of stigmata of this species will have two forms, the primary

form of four rows and the secondary form of five rows. The same forms will be found in the blastozooids of *P. bermudensis* (Berrill, 1932).

Summary

The formation of the rows of stigmata in the blastozooids of *Perophora orientalis* Ärnback which was collected at Misaki-Machi, Kanagawa Prefecture was observed. In the young bud, *ca.* 0.4 mm in length and 0.3 mm in width, the rows of the stigmata are four in number. The number of stigmata of the first row is eight fundamentally. Those four rows are considered as the primary rows of the stigmata of this species. Then the secondary upper and lower two rows are added on the line of the primary first row at the stage of the bud of *ca.* 0.6 mm in length and *ca.* 0.5 in width. Ärnback (1935) mentioned that it has five rows of stigmata, even in the small individuals, and that a few stigmata in the first and the second rows have double length and are common to both rows, though crossed by the transverse vessels. Yatsu (1941) described that *P. orientalis* has five rows of stigmata. According to the writer's investigation, four rows of stigmata are the primary form in the young bud and the fifth row is formed secondarily in addition to the primary four rows. The writer suggests in this paper that the presence of four rows of stigmata would be an important character of this species in addition to the form of five rows. The writer also proposes in this paper a Japanese species name Tsuyuboya for *P. orientalis*.

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MORPHOLOGICAL OBSERVATIONS OF ASCIDIAN LARVAE

1. *CYATHOCORMUS MIRABILIS* OKA, 1913

By

ETURÔ HIRAI

平井越郎

*Marine Biological Station of Tôhoku University, Asamushi,
Aomori Prefecture, Japan*

(With 1 Figure)

In 1951 the writer reported the summary of his work on the comparative study of the structures of ascidian tadpoles as one of the bases of the taxonomic character (Hirai 1951). The present paper deals with the larval organization of *Cyathocormus mirabilis* Oka, 1913 which belongs to the Type I, *Cynthia* Type, according to the writer's opinion. Oka (1913) investigated this species from the systematical point of view on three points; the external form of the colony, the anatomical structure of the zooid, and the structure of the larva. And he proposed his new family, Cyathocormidae, basing on the highly specialized external form of the cup-shaped colony of this species. He stated that the anatomical structure of the zooid of this species seems closely related to genus *Colella* among the *Distomidae* and to *Diplosoma*. On the structure of the larva he described that it "looks very much like that of *Diplosoma*". The writer had the opportunity to observe the structures of the larva of the type specimen of this species and compared it with those of *Diplosoma* and other species. He could not find any close relations to the larva of *Diplosoma*, but he found a close resemblance to the larvae of genus *Distaplia* of the Type I, *Cynthia* type (Hirai 1951). It is noticeable that the character of this species shows the close relation to *Distomidae* in the structure of the zooid as pointed out by Oka and also in the structure of the larva of the writer's opinion.

Before going further, the writer thanks Prof. I. Motomura for his kind supervision, and Prof. H. Oka for his permission to study the ascidian collection of the late Dr. A. Oka.

* Contributions from the Marine Biological Station, Asamushi, Aomori Ken, Japan.
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(1) Diagnostic Characters of the Larva (Fig. 1, a and b)

Form and size: External form is of the stout type. Body is nearly cuboid in form. Total length *ca.* 4 mm, body length *ca.* 1 mm, and 0.7 mm in depth. Tail *ca.* 3 mm in length. There exist three large adhesive papillae at the anterior, and a lobular structure which contains alimentary organs on the ventral side of the body. Tunica transparent and thick.

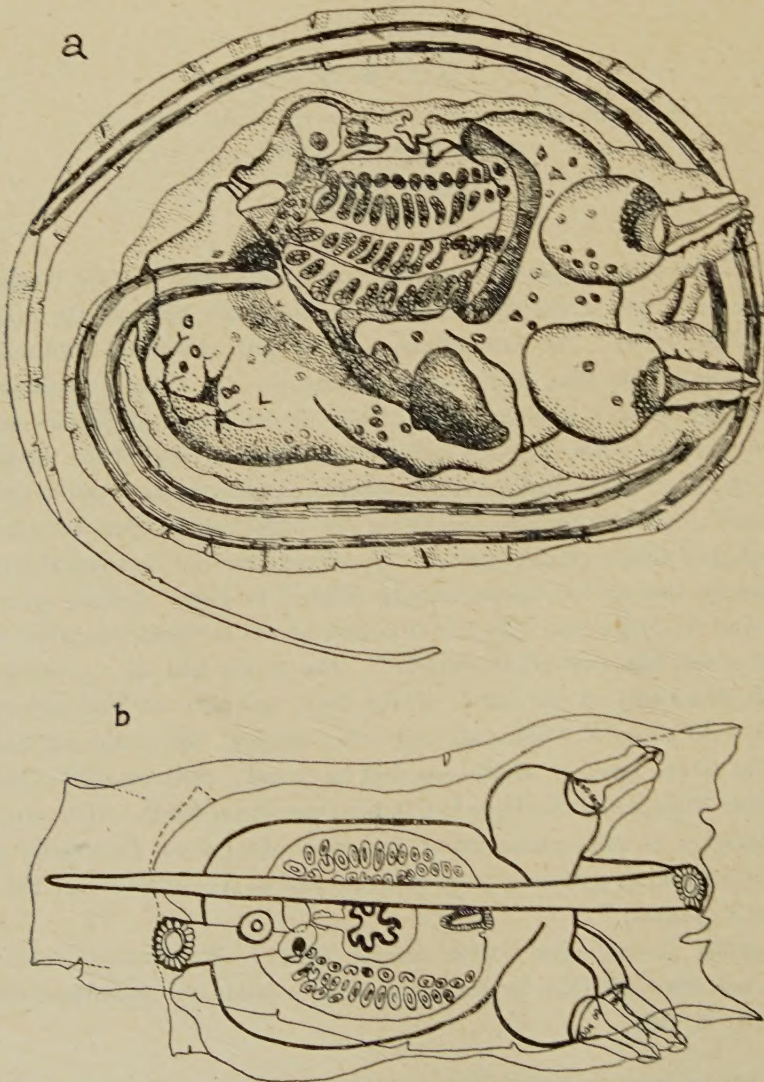


Fig. 1. Tadpole larva of *Cyathocormus mirabilis* Oka.

a. Right side view. $\times 90$. b. Dorsal view. $\times 70$.

Structure of the larval organs : Adhesive papillae large and three in number. They occupy nearly whole area of anterior surface of the body. Each papilla has a basal lobe with a narrow neck. Terminal organ is deep bottle-like and is provided with a long and pointed columnal organ. The wall of the sensory vesicle is thin. The vesicle is spacious with only one sense organ, a static organ which stands on the right side of the ventral floor. Trunk ganglion lies dorso-ventrally or perpendicularly. There is no epithelial process or vesicle. The anterior part of the notochord which penetrates into the posterior part of the body lies in the depth of the latter. Notochord transparent. Tail fin is wide and lateral or horizontal.

Rudiments of the adult organs : The rudiments are visible or well differentiated. Branchial and atrial apertures not projected at the dorsal surface. Six tentacles are simple. Three of them are long and the others are short, and they are arranged alternately. Branchial sac with four rows of stigmata is small, and occupies the middle part of the upper half of the body. Orientation of the endostyle is perpendicular along the anterior margin of the sac. Alimentary organs are separated from the thorax and projected in the antero-ventral direction inclining a little toward the right side with the cover of the epithelial lobe. Stomach is conical in shape. There is a lobular structure of the oesophagus.

Arrangement of the adhesive papillae : The arrangement is of triangular form, and one side of the triangle is dorso-ventral and one corner is observed on the left side.

Relative position of sensory vesicle, branchial and atrial apertures : It is linear and parallel to the cranio-caudal axis on the dorsal side of the body.

(2) Larval Specimen

The larval specimen of this species was obtained from the type specimen in A. Oka's ascidian collection preserved by Prof. H. Oka of Tokyo Bunrika University. The preparation of the larval specimen of this species was added to Oka's collection by the writer.

(3) Remarks

A. Oka (1913) described that the larva of this species looks very much like that of *Diplosoma*. But, according to the writer's opinion the larval type of *Diplosoma* is one of the Subtype 2, *Diedemnum* type of Type II, *Amaroucium* type (Hirai 1951), while that of *Cyathocormus* is to be grouped in the Subtype 2, Compound type of the Type I, *Cynthia* type (Hirai 1951). Those types are quite different in their structure of the larvae. Comparing the larval characters of this species with those of other species, the writer took note of that the larva of this species is closely related to the larvae of genus *Distaplia*: *D. imaii* HIRAI, *D.*

japonica TOKIOKA and *D. magnilarva*. Accordingly, it is estimated that the larvae of genus *Colella* also would have close relations to this species, which have not yet been investigated by the writer. Huus (1933) grouped *Cyathocormus mirabilis* in *Distomidae*. The present writer has the same opinion about the taxonomical position of this species on the view point of the larval organization. He is also of the opinion that the structures of the adult zooid as well as that of the larva must be noted as the principal characters of *Cyathocormus mirabilis*.

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ON THE PLANKTON OF KOEKUCHI-NO-IKE (越口ノ池),
TSUGARU JÛNIKO, (津軽十二湖).*

TETSUSABURÔ OKITSU

沖 津 哲三郎

*Marine Biological Station of Asamushi,
Aomori Prefecture, Japan*

(With 3 Tables)

Koekuchi-no-ike 越口ノ池 is a small lake of the group Tsugaru Jûniko which are situated near Matsukami 松神 on the west coast of Aomori Prefecture. The plankton of this lake has been studied by Kokubo and Kawamura (1940) and Kokubo (1941). The present writer collected and observed plankton of Koekuchi-no-ike three times in 1951-1952. Kokubo (1941) noticed that *Ceratium hirundinella* O. F. Müll. could not be found in Koekuchi-no-ike. In the collection of the writer, on the contrary, this species was found in abundance and moreover two or three other species also showed remarkable changes. In this paper these observations will be described.

Cordial thanks are due to Dr. S. Kokubo for his kind guidance in collections and observation of the samples, and to Prof. S. Nomura and Dr. E. Hirai for preparing the manuscript.

Observation of the Plankton

The collection contains 23 species altogether, of which 12 species are zooplankton and the other 11 are phytoplankton. The relative quantities of these species are given in Table 1.

In the collection of August 3, *Asterionella formosa* was the dominant, and *Ceratium hirundinella* and *Synedra acus* were next abundant, and the largest part of this total quantity of plankton was occupied by these three species. Except the above-mentioned three species, Rotifers such as *Diurella stylata*, *Polyarthra trigla*, *Pompholyx complanata*, and *Peridinium wille* and *Pandorina* sp. were found relatively more frequently.

* Contributions from the Marine Biological Station, Asamushi, Aomori Ken, Japan.
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Table I.
Occurrence of each species of Plankton, denoted in relative
abundance, in Koikuchi-no-ike.

No	Species	XI, 13, 1951	VIII, 3, 1952	XI, 2, 1952
1	<i>Cyclops strenuus</i>	RRR	RRR	RRR
2	<i>Nauplii</i>	RRR	RR	RRR
3	<i>Bosmina longirostris</i>	RR	R	RR
4	<i>Keratella cochlearis</i>	R	RR	+
5	<i>Polyarthra trigla</i>	RR	R	RR
6	<i>Pompholyx complanata</i>	RR	R	RR
7	<i>Diurella stylata?</i>	RRR	+	RR
8	<i>Asplanchna</i> sp.	RRR	RR	RR
9	<i>Coturella</i> sp.		RRR	RRR
10	<i>Notholca</i> sp.		RRR	
11	<i>Peridinium wille</i>	RR	+	RR
12	<i>Tintinnopsis</i> sp.	RR	RRR	RRR
13	<i>Ceratium hirundinella</i>	CC	C	CC
14	<i>Asterionella formosa</i>	CC	CCC	CC
15	<i>Synedra acus</i>	R	C	RR
16	<i>Fragilaria crotonensis</i>		RR	RRR
17	<i>Cymbella</i> sp.	RRR	RRR	
18	<i>Rhopalodia gibba</i>	RRR	RRR	
19	<i>Melosira varians</i>	RR		
20	<i>Pandorina</i> sp.	R	R	RR
21	<i>Anabaena</i> sp.		RR	
22	<i>Dinobryon</i> sp.	R	RR	RR
23	<i>Staurastrum paradoxum</i>	RRR	RRR	RRR

On November 2, *Asterionella formosa* and *Ceratium hirundinella* were dominant, but the former decreased and the latter considerably increased in comparison with the collection of August 3. It is known that the latter changes its form and size in different lakes. *Ceratium hirundinella* of Koikuchi-no-ike measured as follows: —

August 168–274 μ , Average 221 μ (measurements of 100 specimens)

November 173–289 μ , Average 219 μ (measurements of 200 specimens)

The two-spined form and the transitional form were more frequent and the three-spined form was least frequent.

Rotifers, which was abundant in summer, decreased on November 2, but *Keratella cochlearis* increased, and many contained developed eggs. Crustaceans were very rare both in August and November. The association of plankton in November, 1952 was almost the same as that of the corresponding month of 1951.

Water temperature and pH

The water temperature of the lake on August 3, 1952 was 21°C~22°C at the surface and 4°C~5°C in the lower layers. The thermocline layed between 2 m and 10 m, and the maximum gradient was 4.05°C per meter between 4 m and 6 m.

The surface water temperature was lowered by about 10°C from August to November 2, and reached about 11°C, but the temperature of lower layers remained almost the same. The thermocline was lowered by about 6 m and layed between 8 m and 12 m, and the maximum gradient derceased remarkably and amounted to 2.2°C per meter between 8 m and 10 m. In November, 1951 the water temperature was about 10°C at surface layer and about 4.4°C~6.2°C at lower layer, and does not differ much from that on November 2, 1952, but the stratification is more distinct in 1952.

Table 2.
Water temperature and pH

Depth (m)	Water temperature (°C)			pH		
	XI, 13 1951	VIII, 3, 1952	XI, 2, 1952	XI, 13, 1951	VIII, 3, 1952	XI, 2, 1952
0	10.1	21.8	11.1	7.3	8.3	7.5
2	10.0	20.7	11.2	7.3	8.3	7.6
4	9.9	17.6	11.0	7.3	7.2	7.6
6	9.8	9.5	11.2	7.3	7.1	7.6
8	9.8	7.6	11.2	7.3	6.8	7.6
10	6.2	6.5	6.8	6.8	6.8	6.9
12	5.3	5.7	5.8	6.8	6.8	6.9
14	4.9	5.1	5.5	6.8	6.8	6.9
16	4.5	5.1	4.6	6.7	6.8	6.9
18	4.4	4.4	4.5	6.7	6.8	6.8
20		4.4	4.3		6.8	6.8
22		4.2	4.2		6.7	6.7

In August, pH value showed a conspicuous stratification, surface, pH 8.3, middle layers, about pH 6.9, lowers, pH 6.8. In November, 1951 and 1952, middle and lower layers showed almost the same value as in August, but the surface pH was lower considerably. The maximum gradient of pH value lies between 8 m and 10 m in November, and between 2 m and 4 m in August. The gradient in the latter case amounts to pH 0.55 per meter.

General Consideration

A comparison of the main species of Kokubo's collection and mine was given in Table 3.

Ceratium hirundinella, which was not found in 1941, was observed in

Table 3.
A comparison of the main species of the collections in 1941
and in 1952.

Sepecies	1941		1952	
	VIII, 18	XII, 9	VIII, 3	XI, 2
<i>Diaptomus pacificus</i>	R	C		
<i>Cyclops strenuus</i>	RR	RR	RRR	RRR
<i>Daphnia longispina</i>	C	RR		
<i>Bosmina longirostris</i>	RR	RR	R	RR
<i>Keratella quadrata</i>	R	R		
<i>Keratella cochlearis</i>	RR	RR	RR	+
<i>Polyarthra trigla</i>	RR	RR	R	RR
<i>Pompholyx</i>		RR	R	RR
<i>Diurella</i>			+	RR
<i>Ceratum hirundinella</i>			C	CC
<i>Asterionella formosa</i>	C	+	CCC	CC
<i>Melosira granulata</i>		CC		
<i>Synedra acus</i>			C	RR
<i>Volvox aureus</i>	CC			

abundance in my collection. Kokubo (1941), Kokubo and Kawamura (1948) noticed that *Ceratum hirundinella* appears commonly in the lake groups on Nigori-ike 濁池, Menkozaka-no-ike 面子坂ノ池 and Itohata-no-ike 絲畑ノ池, but does not appear in the lake group Koekuchi-no-ike, comprising Koekuchi-no-ike, Ô-ike 王池, etc, while the conditions there are favourable for production of this species.

According to Kokubo and Kawamura (1948), *Ceratum hirundinella* of Ô-ike 大池 measures 161–210 μ , average 201 μ , and the three-spined and transitional forms are abundant, while the specimens from Menkozaka-no-ike measure 170–238 μ , average 209 μ ; and those from Itohata-no-ike measure 188 μ on the average. Moreover, specimens from Lake Akimoto and Lake Hibara measure respectively 331 μ and 367 μ on the average, and the three-spined form dominates. Compared with specimens of above-mentioned lakes or ponds, *Ceratum hirundinella* of Koekuchi-no-ike is somewhat larger than those of Ô-ike and of Menkozaka-no-ike, and considerably smaller than those of Lake Akimoto and Lake Hibara.

Crustaceans seem to be considerably scanty. *Cyclops strenuus* and *Bosmina longirostris* appeared in small quantities, and *Diaptomus pacificus* and *Daphnia longispina*, which was leading species in 1941, could not be found. *Melosira granulata* and *Volvox aureus* scarcely appeared, while *Asterionella formosa* is again dominant species in the present collection. Rotifers seems to be a little more abundant than before.

Compared with the results of Kokubo (1941), it is a remarkable fact that the

dominant species have undergone considerable changes. The water temperature and pH value do not show much difference from those in 1941.

As to the cause of the changes just mention, it would be an interesting problem to pursue in the future study.

Summary

The plankton of Koekuchi-no-ike, Tsugaru Jūniko, was collected in November 1951, August and November 1952, and was compared with the collection by Kokubo (1941). As a result, it has been found that *Ceratium hirundinella*, which did not appear at all in 1941, was observed in abundance, about ten years later since the previous collection by Kokubo. On the contrary, *Diaptomus pacificus*, *Daphnia longispina* and *Melosira granulata* could not be found as far as my collection was examined.

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ON THE SEASONAL CHANGE OF *CERATIUM* IN
AOMORI BAY*

TETSUSABURŌ OKITSU

沖 津 哲三郎

*Marine Biological Station of Asamushi,
Aomori Prefecture, Japan*

(With 1 Figure and 2 Tables)

Taxonomical studies of Dinoflagellata, abundantly found in the plankton of Aomori Bay, have been made and the results have been reported by T. H. Abe (1927).

The writer in 1946 observed the seasonal change of *Ceratium* collected at a definite station off the Marine Biological Station of Asamushi, and briefly reported the results at the extraordinary meeting of the Japanese Society of Scientific Fisheries (Okitsu and Kokubo 1952). The writer will report the results more in detail in the present paper.

Acknowledgements are due in this article to Dr. S. Kokubo for his kind guidance in the study, to Prof. S. Nomura and Ass't Prof. E. Hirai for preparing the manuscript.

Material and Method

Vertical collection of plankton was made twice a month at a definite station west of and 1 mile off the Marine Biological Station of Asamushi, the depth being 30 m. The plankton net was made with Müller gauze No. 14, and the diameter of the mouth was 30 cm and the length 100 cm.

The sample of plankton was fixed with 5-10 % formalin, allowed to stand in a measuring cylinder for 24 hours, and then the settling volume was read. Samples of definite amounts were taken from this settling volume and were examined. The identification of species was made mainly according to T. H. Abe (1927) and Jörgensen (1911).

* Contributions from the Marine Biological Station, Asamushi, Aomori Ken, Japan.
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Results

The collection of plankton made by the present writer comprises 26 species given in Table 1 and Figure 1.



Fig. 1. Seasonal change of *Ceratium* in Aomori Bay during 1946.

Ceratium fusus appeared abundantly in August and late in November, and diminished markedly in June and July. It was only this species that appeared all round the year. *Ceratium macroceros*, *C. macroceros* subsp. *gallicum* and *C. massiliense* appeared in small amount in January and February, and abruptly increased in number in August, and reached their respective maximum in the latter part of August to September. Then they gradually decreased, but continued at a definite level until December. *Ceratium tripos* var. *atlanticum* appeared and abruptly increased at the beginning of August, and decreased suddenly in September, but slightly increased again in November. *Ceratium bucephalum* var. *heterocamptum* appeared in considerable amounts in June, November and December. *Ceratium lineatum*, *C. pulchellum* and *C. trichoceros* began to appear in July or August and reached their maximum in November. *Ceratium pennatum*, *C. inflexum*, *C. extensum*, *C. pentagonum*, *C. candelabrum* var. *dilatatum*, *C. carriense*, *C. contortum*, *C. gibberum*, *C. gracile*, *C. molle* and *C. breve* appeared from the latter part of September to December. These species appeared remarkably in small amounts and did not almost occur in other seasons.

In Table 2, the main species above-mentioned are arranged in the order of

Table 2
Species of *Ceratium* arranged in the order of abundance in each month.

Month \ Order of abundance	1st	2nd	3rd
I	<i>C. fusus</i>	<i>C. macroceros</i>	<i>C. bucephalum</i> var. <i>heterocamptum</i>
II	<i>C. fusus</i>	<i>C. macroceros</i>	<i>C. bucephalum</i> var. <i>heterocamptum</i>
III	<i>C. fusus</i>		
IV	<i>C. fusus</i>		
V	<i>C. fusus</i>	<i>C. bucephalum</i>	<i>C. tripos</i> var. <i>atlanticum</i>
VI	<i>C. fusus</i>	<i>C. furca</i> subsp. <i>eugrammum</i>	
VII	<i>C. tripos</i> var. <i>atlanticum</i>	<i>C. bucephalum</i> var. <i>heterocamptum</i>	<i>C. fusus</i>
VIII	<i>C. fusus</i>	<i>C. tripos</i> var. <i>atlanticum</i> <i>C. macroceros</i>	<i>C. massiliense</i>
IX	<i>C. macroceros</i>	<i>C. trichoceros</i>	<i>C. massiliense</i>
X	<i>C. trichoceros</i> <i>C. fusus</i>	<i>C. macroceros</i>	<i>C. massiliense</i> <i>C. pulchellum</i> <i>C. lineatum</i>
XI	<i>C. fusus</i>	<i>C. trichoceros</i>	<i>C. macroceros</i> <i>C. tripos</i> var. <i>atlanticum</i>
XII	<i>C. fusus</i>	<i>C. massiliense</i>	<i>C. macroceros</i> <i>C. bucephalum</i> var. <i>heterocamptum</i>

abundance in each month.

General Consideration

N. Frost (1938) has stated that in Newfoundland, appearance and abundance of species of *Ceratium* change with slight differences of water temperature, so that *Ceratium* is valuable index of oceanographical conditions.

In 1946, north temperate species such as *Ceratium fusus*, *C. macroceros* and *C. lineatum*, appeared in abundance in Aomori Bay. The main species of tropical or subtropical species were *Ceratium trichoceros*, *C. inflexum*, *C. candelabrum* var. *dilatatum*, *C. carriense*, *C. contortum*, *C. contortum* var. *saltans*, *C. gibberum*, *C. gibberum* f. *sinistrum*, *C. molle*.

In the earlier half of 1946, the occurrence of *Ceratium* was meagre. However, in the season from September to December, the quantity and the species increased markedly (Tab. 1). Moreover, the tropical or subtropical species above-mentioned

appeared in large numbers in this season. This phenomenon may be considered as due to the effect of the Tsugaru Warm Current which has entered Aomori Bay in autumn, as reported by Kokubo (1946, 1952) in his studies on copepods and diatoms.

Summary

Seasonal change of *Ceratium* at one mile off Asamushi in Aomori Bay was observed for one year of 1946. The collection of *Ceratium* comprised 26 species: *Ceratium fusus*, *C. macroceros*, *C. macroceros* subsp. *gallicum*, *C. massiliense*, *C. bucephalum*, *C. bucephalum* var. *heterocamptum*, *C. tripos* var. *atlanticum*, *C. furca* subsp. *eugrammum*, *C. lineatum*, *C. pennatum*, var. *falcatum*, *C. pennatum* var. *scapiforme*, *C. pulchellum*, *C. trichoceros*, *C. inflexum*, *C. extensum*, *C. pentagonum* f. *robustum*, *C. candelabrum* var. *dilatatum*, *C. carriense*, *C. contortum*, *C. contortum* var. *saltans*, *C. gibberum*, *C. gibberum* f. *sinistrum*, *C. gracile* var. *symmetricum*, *C. molle*, *C. breve* var. *parallelum* and *C. belone*. Seasonal change of these species were given in Table 1 and Figure 1.

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OCEANOGRAPHICAL OBSERVATIONS OFF ASAMUSHI DURING 1952*

By

TETSUSABURÔ OKITSU, TOSHINOBU TOKUI** and BUNRYŪ TSUBATA

沖津 哲三郎 徳井 利信 津幡 文隆

*Marine Biological Station of Asamushi,
Aomori Prefecture, Japan*

(With 4 Figures and 1 Table)

Introduction

Oceannographical observations have been carried out, since 1927 until the present except two years 1944 and 1945, as the routine work by the members of the Marine Biological Station of Asamushi, Tôhoku University, at a fixed station about 2 miles off the laboratory just mentioned and of a depth of about 30 metres. The present report deals with the data of observations made during the period of January to December, 1952. The results of observations in the preceding years were reported in the works given in the literature at the end of the previous paper of the present authors (1953).

The water temperature was measured by Okitsu from January to April and by Tsubata thereafter. Okitsu and Tokui presented their data to Tsubata, who has dealt collectively with all the data obtained by all the present authors.

The method of observation was the same as has been employed in the previous work and the frequency of the observations was twenty times all together as is given in Table 1.

1. Water Temperature

In 1952, the minimum water temperature in every layer of 0, 5, 10, 20 and 30 metre depths appeared in the latter part of February to March, and the maximum temperature at the surface in the middle of August, that at the 10 m depth in August to September, and that at the 30 m depth in the middle of September (Fig. 1). Inverse stratification did not develop in 1951, while it

* Contributions from the Marine Biological Station, Asamushi, Aomori Ken, Japan.
No. 210

** Present Address: Wainai Hatchery, Towada, Aomori Prefecture

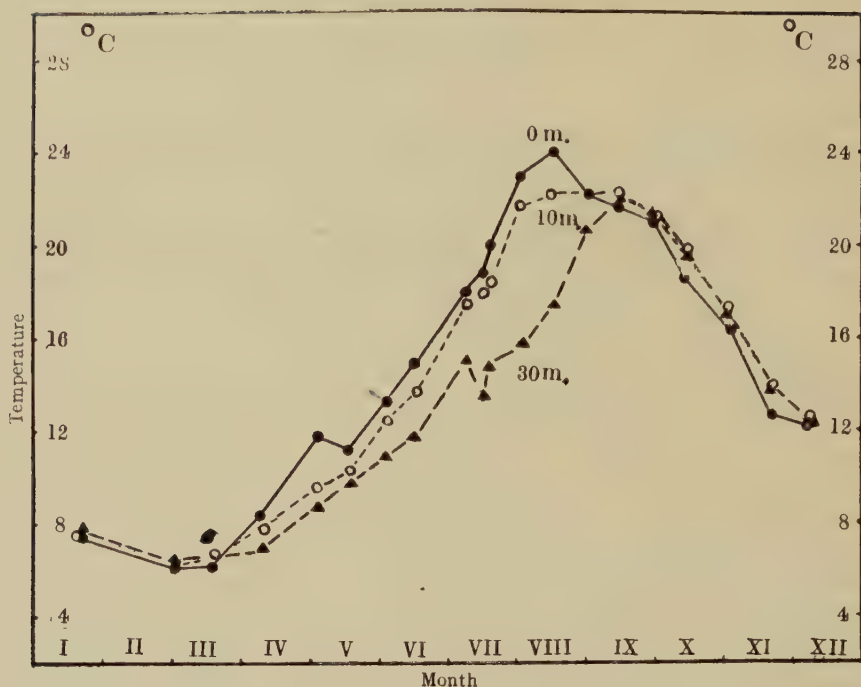


Fig. 1. Annual change of temperature at different depths during 1952.
Ordinate-temperature; Abscissa-month.

developed well in 1952, and the year could be divided into two periods of direct and inverse stratification, as was previously pointed out by Kokubo and Tamura (1938). The season from April to September is the period of direct stratification and the period of October to March makes the period of inverse stratification. That the inverse stratification did not appear in Aomori Bay in 1951 belongs to a rare case, and 1952 seems rather to be a normal year.

As compared with the curves of water temperature in 1951, the temperature curve of the surface in 1952 shows some resemblance, but the curves of 10 m and 30 m depths present some differences, and at the latter depth the temperature rise after the middle of July is smaller and it is conspicuous that the temperature in 1952 is lower than in 1951 until the maximum is attained in September. At the surface and the 10 m depth, the temperature gradually rose from the last decade of March to August, but at the 30 m depth the rising curve of temperature was broken in the middle of July and the temperature once fell down and rose again, but the rise was much delayed. This suggests an invasion of cold water mass in the depths.

While the water temperature in Aomori Bay is generally considered to be

influenced by climatic conditions, it is a conspicuous fact that a cold water mass must have appeared in the depths off Asamushi in July to September, as has just been mentioned.

2. Chlorinity

The annual change of chlorinity off Asamushi in 1952 (Fig. 2) indicates that the chlorinity at the surface is low and variable, while in 10 m and 30 m layers it increases with the depth and less variable, fluctuating between 18.3 and 18.9 ‰.

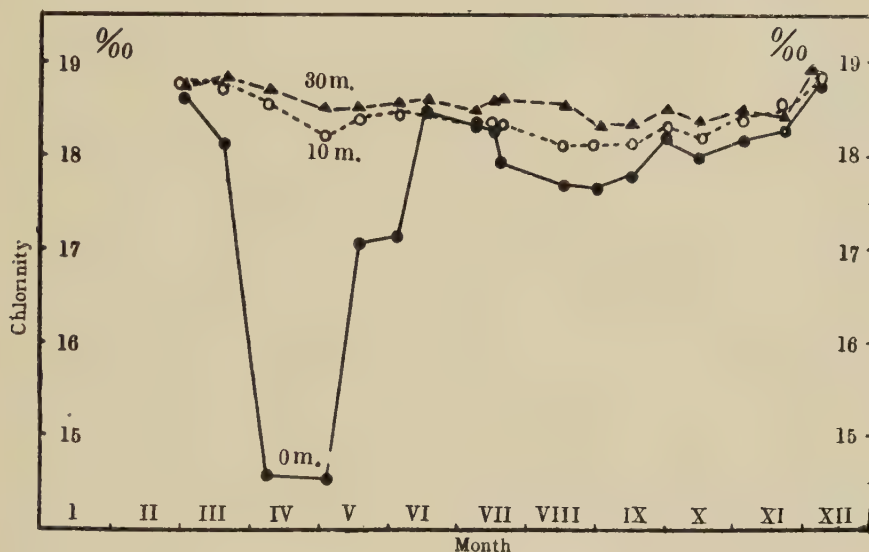


Fig. 2. Annual change of chlorinity at different depths during 1952.
Ordinate—chlorinity in ‰; Absissa—month

The surface chlorinity in February did not differ much from those at 10 m and 30 m depths and amounts to about 18.63‰, which is rather a high value. From March it gradually decreased and in April and May it was greatly lowered down to low values 14.59 to 14.55‰, then recovered to 18.50‰ in June, approaching the values at the 10 m and 30 m depths. From the last third of July, it gradually decreased, but recovered towards December. The annual change of surface chlorinity generally follows such a course as just described, but no such decrease of chlorinity as in July of 1951 was observed in 1952.

While the water temperature in July to September indicated the invasion of a cold water mass in the depths, the chlorinity did not show such a distinct evidence of a cold water mass. The chlorinity did not also show inverse stratification even in the period of inverse stratification of temperature, showing low values near the surface and increasing with the depth of water.

3. Dissolved Oxygen

The annual changes of dissolved oxygen and its percentage saturation at the station in 1952 are shown in Figs. 3 and 4. In February, dissolved oxygen am-

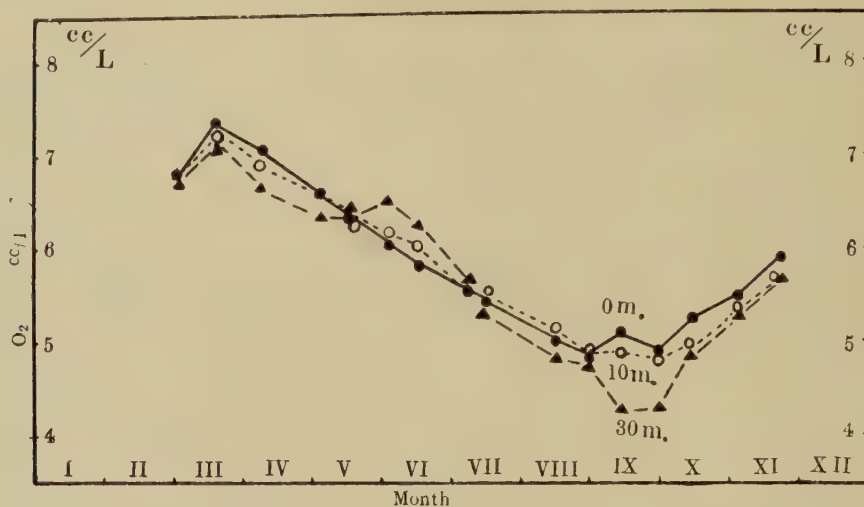


Fig. 3. Annual change of the O₂ content of sea water at different depths during 1952.



Fig. 4. Annual change of saturation of O₂ at different depths during 1952.

mounted to about 6.8 cc/l and the layers did not differ much from one another. In March, each layer showed an increase of oxygen; the surface layer contained

7.36 cc/l, 30 m layer 7.21 cc/l. This would be due to a great growth of phytoplankton which produce oxygen in photosynthesis, and each layer shows supersaturation over 103 %. From April to July, the oxygen content of all the layers gradually decreased and the surface layer reached the minimum at the end of August, and the 10 m and 30 m depths attained their minimum near the end of September; then the oxygen content gradually increased. At the surface and the 10 m depth, the saturation fluctuated around 100 % from April to July, then decreased to 95-96 %. At the 30 m depth, the oxygen saturation decreased down to 87-73 %, probably due to the appearance of the cold water mass mentioned under the heading of the water temperature.

The comparison of Fig. 1 and Fig. 3 reveals that the tendencies of the changes in the water temperature and in the oxygen content are just the inverse of each other. A similar interesting phenomenon was pointed out by Kokubo and Tamura (1938).

4. Summary

1. The present report deals with the oceanographical observations carried out at a fixed station off the Marine Biological Station of Asamushi during the period from January to December, 1952.
2. The annual change of the water temperature in this year followed the normal course and the year could be divided into two periods of direct and inverse stratification. The alleged appearance of a cold water mass at the 30 m depth from the middle of July to September was a remarkable fact.
3. The chlorinity at the 10 m and 30 m depths was almost invariable, while at the surface layer there was a remarkable decrease of chlorinity during the thaw period of April and May.
4. As to the oxygen content, the maximum appeared in March in every layer and the minimum appeared from August to September. This change in oxygen content is just the reverse of the change in the water temperature.

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昭和29年3月25日印刷

昭和29年3月30日発行

編集兼 東北大学附属臨海実験所
発行者 青森県浅虫
電話 浅虫45

印刷所 笹気出版印刷株式会社
仙台市堤通27番地
電話 ㊤2027, ㊤2207

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**All communications intended for "THE BULLETIN OF THE
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should be addressed to the Director, Prof. S. NOMURA,
The Marine Biological Station, Asamushi,
Aomori Prefecture, Japan.**